BULLETIN

THE AMERICAN INTERPLANETARY SOCIETY

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David Lasser, President Clyde J. Fitch, Editor.

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THE CONQUEST OF SPACE BY ROCKET

(Summary of an address delivered before the Society on February 18, 1932 by G. E. Pendray)

When we organized the American Interplanetary Society two years ago, we had only a mass of theoretical and mathematical data behind us, and a few meagre and disappointing experiments.

Now let me tell you what has transpired in the two years since the Society was founded---events which have transformed the whole face of the rocket problem; which have placed it on a sound engineering basis, and have given us substance upon which to stand when we come before you tonight with the assertion that rockets will someday in the near future bring about changes more revolutionary than those wrought even by the automobile and the airplane, changes which will shrink earth distances into insignificance, and put us in touch with the moon and our neighbor planets.

One of the first of these events was the gift to Dr. Goddard of an ample fund for his experiments. In the summer of 1930 the late Simon Guggenheim gave Dr. Goddard the sum of $100,000 to complete his experiments on meteorological rockets. Dr. Goddard is now in his laboratory in New Mexico, whence word comes by way of the Smithsonian Institution that he has perfected an automatic stabilizing device which will control his rockets in flight. If these second-hand reports are not exaggerated, then the two fundamental problems of rocketry may be already solved by Dr. Goddard, and the day of mail rockets, passenger rockets, and even interplanetary shots may be much closer than even the most enthusiastic of us think.

But Dr. Goddard himself has made no statements, and has enshrouded his experiments in a curious secrecy which has caused the majority of us to look else-

where for signs of progress in this difficult new field of engineering. These signs are not hard to find. In France Robert Esnault-Pelterie, whose book "L'Astronautique" may perhaps be called the mathematical textbook of the new science, has been carrying on a series of difficult and dangerous tests of various liquid explosives with a view of building a rocket making use of them.

In Russia and in Austria two new societies, similar to our own, have sprung up to foster experiments and to finance them. In Italy and even in Africa rocket experiments of importance are now going forward, and from any one of a dozen points word may come any day that a fine altitude shot, or a new development has been made which may solve one or more of the intricate problems connected with the design or control of rockets.

But these are not accomplishments; they are only promises. Yet we hardly even had promises two years ago, and today we have actual accomplishments to bring to your attention.

In Germany a great organization of more than a thousand members, has opened a rocket flying field on the outskirts of Berlin, and now has six or seven full-time engineers working on the rocket problem.

Naturally with such a force and facilities great strides have been made there. A number of liquid fuel rockets have been built, and last summer, for the first time, successful liquid-fuel rockets were flown at the Raketenflugplatz. One of these rockets made an altitude of more than a mile. Another was shot at an angle, and succeeded in striking a target more than three miles away.

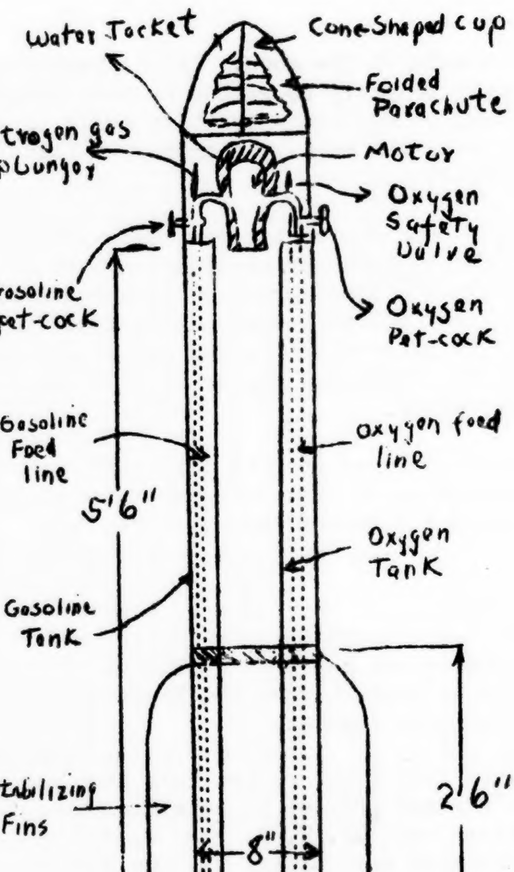
Today the German engineers are engaged in building a larger rocket, capable of making an altitude of twenty-five miles or more. It will have three motors, and will be able to lift about a quarter of a ton, including its own weight, its fuel, and the instruments which will be sent along with it. One motor of this rocket is already completed and has been tested on the proving-stand. It is about eighteen inches long, and has a lift of nearly 180 pounds.

Other German engineers, working independently of the Society, have also been making important experiments. Among them is Reinhold Tiling, who recently sent a dry fuel rocket to an altitude of six miles. Tiling's special contribution is not in the field of fuel development, but in that of flight control and landing. His rockets bear an unique set of wings, which serve as vanes for directing the flight going up, and as autogyro wings coming down. This scheme, which has been unusually successful, does away with the uncertain parachute, and may show us a way to develop rocket planes, which will be fast-moving projectiles for the major part of their flight, and will suddenly put out wings and mañeuver to a landing like airplanes or gliders.

Tiling is now at work improving his device further, and may make an even greater shot this summer.

In the meantime Americans have not been idle. Besides Dr. Goddard there is Harry W. Bull, of Syracuse, New York, and Cleve Shaffer, of San Francisco. Both of these men are members of the American Interplanetary Society. The results of their experiments are being made available to other members, so that there will need to be no duplication. A similar arrangement has been made between the American and German societies, through the efforts of Mr. Lasser. Now experiments are proceeding on both sides of the water, aided by whatever has been discovered by other experimenters.

Mr. Shaffer is at work on a device by which he hopes to get power from rocket motors for terrestrial uses by use of the principle of the pin-wheel. His specially developed motors, upon which he is now experimenting, will probably be mounted at the ends of a propeller-like arrangement, the fuels being fed to them through the shaft. Experiments along the same lines are being carried out also by another member of the Society, William T. Heyer, of Greenwich, Conn.



Schematic drawing of the Rocket of A.I.S. Length overall 7 feet

More important still are the experiments of Mr. Bull, at Syracuse, Bull will be remembered as the young man who built a rocket sled a year ago this spring, and rode on it as the contrivance shot over the ice near Syracuse. A part of the laboratories of Syracuse University have been set aside for his use, and he has set up a very fine proving-stand there for studying rocket motors under controlled conditions.

While the German experimenters have also made proving stand tests, those now being made by Mr. Bull will probably be the most complete ever undertaken, and when they are finished the Society will have available an extremely fine set of results upon which specifications for future rocket motors can be confidently based.

Mr. Bull himself expects to build a rocket soon, based upon his own findings. It will probably be tri-motored, and will have a steering and stabilizing device worked out by himself.

But I do not mean to weary you with engineering details. I only wish to show you that in the last two years---perhaps I should say in the last year, or in the last nine months---rockets have become an accomplished fact, and experimenters are making surprising and rapid strides, in spite of depression, disappointment and almost world-wide skepticism. Two years ago rocketry was a romantic---perhaps a foolish dream. Today it is a young but growing field of experimental engineering.

We now believe that the development of rockets will pass through four distinct stages, of which the first is nearly here. The second should be a matter of only five years or less; the third within the decade, and the fourth, if money is available for the necessary experimentation, could be realized within this generation, and many now living---perhaps some of us in this room tonight, will live to see it accomplished.

The first stage is that of the meteorological or high-altitude rocket, carrying instruments into the upper reaches of the atmosphere---perhaps to its limit and into space. The second will be the development of accurate and controlled mail and express rockets, carrying parcels with tremendous speed from place to place on the earth. These rockets will cross the Atlantic in about two hours; will fly from New York to Chicago in twenty minutes, and will be able to pass completely around the earth---if that is desired---in a little more than six hours.

The third stage will be the development of passenger-carrying rockets---huge ships which will convey human beings from San Francisco to New York in less than two hours, perhaps running on regular hourly schedules to points all over the world.

Finally, we shall see the first shots made at the moon. In the beginning these moon rockets will be unmanned. They will probably be guided by some adaptation of the radio able to penetrate into space, or by light-sensitive cells or other devices. They will signal their arrival on the moon by a magnesium flare large enough to be detected by modern telescopes.

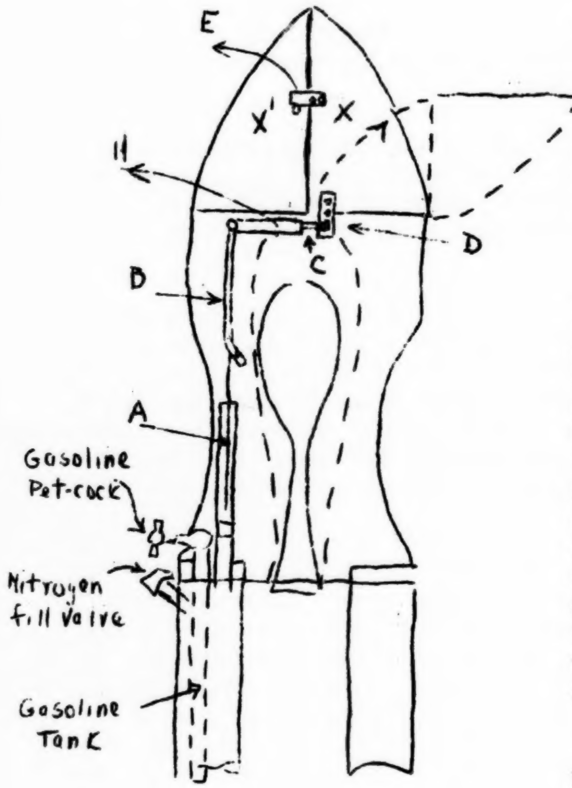
When it has been demonstrated that the moon can be hit six times out of ten with rockets of this type, it is likely that a party of hardy scientists or explorers will make the attempt. Very probably the first group will be lost, for even though the control of rockets will have been solved completely by that time, the difficulties of navigating in space will be so great as to tax the abilities of any voyager. But ultimately a moon shot will succeed. Explorers will not only reach the moon, but will return from it safely.

We are still engaged in accomplishing the first step in this series of rocket advances. We have yet to shoot a liquid-fuel rocket---or any other kind, out of the earth's atmosphere, or even to plumb the strata twenty, fifty or a hundred miles up.

I believe that this will be done within two or three years, perhaps sooner. In fact, it may be done by this Society, if money enough is made available through memberships to pay for the experimental program which has been outlined. It is to show you what we have already been able to accomplish that the Experimental Committee decided to show you our first rocket here tonight.

The necessary costs in connection with this first rocket have been borne by one of the members of the society who at present prefers to remain anonymous. The bulk of the work of construction has fallen upon Mr. H. F. Pierce, who has worked without compensation and who has originated most of the various devices necessary to shoot the rocket successfully and open its parachute at the proper time. It was designed principally by myself and Mr. Pierce, but we do not wish to let this opportunity go by without acknowledging the help we have received from the engineers of the Air Reduction Company, notably Mr. Philip Gross, Mr. H. W. Reade, Mr. J. J. Crow, and Dr. F.S. Metzger and from Dr. H. H. Sheldon of New York University.

We patterned the rocket in general after one of the successful German liquid fuel rockets---the type known as the two-stick Repulsor, but it contains so many changes and innovations of our own that it must stand or fall upon its own merits, and can now hardly be blamed or credited to its German ancestor. The nature of some of these innovations we do not mind revealing at this time; others must be left unmentioned until they have had a field trial and proved whether or not they are of any assistance.



Schematic Drawing of Parachute Release Apparatus for A.I.S. Rocket.

Nitrogen gas pressure pushes up gas piston **A**, which engages member B, lo k-ing it up at H, forcing key C into slot in lug of cone member D. Cone member X' is held shut by lug E of cone member X. When gas pressure releases A, B is released and part **H** swings downward releasing key C. This frees D and cone-member X which flies out as shown. X' is then also released and flies out on the opposite side, springing the catch on the parachute pan inside (not shown) throwing parachute clear.

The fuels to be used in this rocket are gasoline and liquid oxygen, burned in the proper proportions in the combustion chamber, usually referred to as the motor of the rocket. It is made of a special alloy, and was cast by the Aluminum Company of America from a pattern made upon specifications designed by ourselves.

The motor of a rocket is the heart of the contrivance, but it must not be confused with the gasoline or electric motor. There are no moving parts. The fuels to be burned are jetted into the motor under considerable pressure, and the combustion takes place inside the chamber. The process of burning generates great heat and an enormous volume of gas, the molecules of which are moving at a very great speed. The gas has only one way to escape---through the nozzle, and when the rocket is in operation a spurt of yellowish flame two or three feet in length will shoot downward from the nozzle.

The rocket motor will then lift or push in a direction opposite to the nozzle---the push depending upon the pressure developed by the gas in the chamber, and the cross section of the nozzle. If the gas pressure is equal to 150 pounds per square inch we shall have, with this motor a lift a little better than 30 pounds. Since our rocket weighs only 15 pounds loaded with fuel, the upward acceleration at the beginning of the flight should be about equal to that of falling 32 feet per second per second. As flight continues the rocket will become lighter because the fuels will be burning up. The lift, however, will remain constant, as a result of which the upward acceleration will increase, approaching 64 feet per second per second at the end of the firing period.

The height to which the rocket will go depends upon the length of the firing time and the speed attained. The firing time in turn depends upon the amount of fuel carried along and the rapidity with which it enters the combustion chamber. All these things taken into consideration lead us to believe that this rocket is

capable of reaching an altitude of three or four miles. Actually, we shall not try to shoot it so high, because of the difficulty of controlling its flight, and because we haven't found a large enough space in which to shoot it to make certain that it will not do damage when it comes down.

The idea in building this rocket is not to make an altitude record, but to try out certain appliances which we hope to incorporate later in a larger and more efficient rocket. We shall, therefore, make a number of small flights, hoping to recover the rocket each time in an undamaged condition, so that it can be shot repeatedly.

The problem of using liquid fuels is by no means a simple one. With a dry fuel such as gun powder, the explosive can be packed into a tube by mechanical pressure and burned there, the tube also serving as a combustion chamber. With liquid fuels the combustion chamber must be separate from the fuel tanks, and the fuels will have to be forced into the chamber in a given ratio and at a uniform velocity, against the pressure which the combustion generates. This requires the use of pumps or gas pressure behind the liquids. In our rocket we have chosen to use gas pressure.

One of the fuels is liquid oxygen and the other gasoline. Now liquid oxygen is a very cranky stuff. It boils at any temperature above minus 298 degrees Fahrenheit and the problem of keeping it cold enough in a tank situated only a few inches from the extreme heat of the combustion chamber is serious. In our rocket we permit the oxygen to build up gas pressure by its boiling. This pressure is used to force the liquid oxygen into the chamber during the period of firing. Unfortunately, the problem of pumping the gasoline cannot be settled so easily. In the case of this fuel, we must put some inert gas into the tank to produce the necessary pressure. The gas we have chosen to use is nitrogen, which will be compressed into the gasoline fuel under five or six hundred pounds pressure per square inch.

The fuels are conveyed to the motor through small aluminum tubes, and the portions permitted to enter the combustion chamber are determined by the size of the opening drilled into the chamber. These openings enter through the shoulders that you see on the motor.

Between the fuel tanks and the motor are shut-off valves which are arranged so that they can be opened from a distance by electricity, thus permitting the rocket to be shot while the engineers are safely barricaded behind some kind of breastworks to protect them in case of explosion or other undesirable activity. The handles of these shut-off valves you may see projecting from the sides of the rocket hood.

In the cone-shaped tip of the rocket is a parachute upon which we hope the contrivance will float gently back to earth after each trial. One of the minor problems in connection with building a rocket of this type is that of finding an apparatus which will open the parachute at the proper moment in flight. We have met this problem in our present rocket by taking advantage of the pressure of the nitrogen gas in our gasoline fuel tank. So long as there is pressure in that tank the trigger action which controls the parachute will remain locked, but when the pressure is gone the trigger action will open the split hood and forcibly eject the parachute. We believe that this will open at about the proper time, for there is an excess of gasoline guaranteeing that the nitrogen in the tank will be the last substance to leave the rocket and this will not occur until the firing period is well over.

Now I want to introduce Mr. H.F. Pierce, to whose mechanical ingenuity we owe many of the innovations of this rocket. Mr. Pierce has consented to assist me in giving you a little demonstration of the way in which our parachute will be flung out at the proper moment in the rocket's flight. There are, of course, no fuels in this rocket---to bring them here would have been extremely dangerous---but with the aid of a tire pump we have put about 100 pounds of air pressure in the gasoline tank and it is that pressure which is now holding the parachute apparatus in its locked position. The shut-off valve between the gasoline tank and the combustion chamber is now closed to retain the air pressure.

Mr. Pierce has set up his control board on the platform and it is now connected so that we can open this valve electrically and release the air. When I give the signal Mr. Pierce will throw the switch. You will see the wire filament which holds the valve glow and fuse. This releases the valve. The air will hiss into the chamber, and when the pressure is gone the mechanism will work, it will open and the parachute will be thrown out.

The small rocket we show tonight is a start in the direction of interplanetary flight. Further advances in this direction can be made only if scientists and engineers are willing to give their time to the development of the rocket. This Society is encouraging experimentation both by gathering information and making it available to private experimenters and by following an experimental plan of its own. To date the experimentation of the Society has been financed by private means. More ambitious projects will require more money than is likely to be made available in this manner. If they are to materialize, the society membership must grow. Membership costs almost nothing---$3 to $10 a year. A thousand members will permit us to continue these experiments until they are placed upon a practical basis. The future, not only of the Society but of its experimental program is in your hands.

We offer you tonight an opportunity to take part in this tremendous development, a development beside which the most adventurous dreams of other ages are inconsequential. Men of the future will look back upon the era and will see little to interest them in our economic disturbances, in our small personal ambitions and accomplishments. But if the work of developing the rocket is successful they will view this decade as one in which a world revolution of transcendental importance began.

Anyone who wishes to join the Society or to obtain further information about the rocket may do so by writing to the Secretary.

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SOCIETY'S ROCKET TO MEET FINAL TESTS

After being displayed at a meeting of the Society at the Museum of Natural History on February 18 before a large and enthusiastic audience, the seven-foot rocket of the Society is to meet its final tests before being sent aloft.

The tests under the direction of Mr. G. E. Pendry, vice-president of the Society, and Mr. H. F. Pierce will take place at New York University, and at Red Hook,,New York, where the rocket will finally be shot.

Final work on the rocket, which has aroused considerable public interest is being completed so that the shot may take place late in March or early in April. Although the rocket is not designed for a high altitude, but rather to

test the value of its design, a height of several miles may be achieved. If this occurs, the rocket will have the distinction of the altitude record for all liquid-propelled rockets. The rocket altitude record of six miles held by Reinhold Tiling, German engineer, is for a powder-propelled rocket.

It is hoped that the parachute device in the rocket's nose will function satisfactorily so that the rocket can be retrieved and shot a number of times, and its full value can be estimated.

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ROCKET ARTICLES IN RECENT PERIODICALS

An illuminating and well-documented article on the work of the German Interplanetary Society, entitled "From Europe to New York by Rocket?" appears in the March issue of POPULAR MECHANICS, written by G. H. Davis.

According to the note of the editor, the magazine sent Mr. Davis to Berlin to obtain full information on the actual accomplishments of the German Society and to obtain diagrams of their present and proposed rockets.

An article, "The Rocket in the Next War?" by David Lasser, president of the American Interplanetary Society appears in the March issue of Everyday Science and Mechanics. Mr. Lasser shows the rocket to be an enormously destructive weapon as well as a revolutionary agent of transportation and exploration.

A signed article by Dr. Robert H. Goddard, describing his new rocket plane appears in the March issue of the Scientific American. This article reprinted from the New York Times reaffirms Dr. Goddard's belief that the rocket plane will supplant the propeller plane for high-altitude, long-distance transportation.

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SCHEDULE OF FUTURE SOCIETY MEETINGS

On Friday evening March 11, Mr. Alvin J. Powers will speak on " A theory of gravitation and the stellar evolution".

On Friday evening, March 25, Dr. H. H. Sheldon, head of the Physics Department, Washington Square College, New York University, will speak on "The Future of the Rocket."

On Friday evening April 8, the Society will hold its third annual meeting.

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EDITORIAL COMMENDS SOCIETY'S WORK

The following editorial, which appeared in the New York Herald Tribune of February 18, 1932 is reprinted here as an encouraging response of a great metropolitan newspaper to the work of the American Interplanetary Society. The editorial in its entirety follows:

"THE SPACE SHIP"

"The American Interplanetary Society, that most engaging of amateur scien-

tific groups, promises to exhibit tonight to an admiring public its first large-sized rocket. For the public, whether it admires the rocket or not, cannot fail to admire the earnestness of these enthusiasts of interplanetary navigation, who at the cost of considerable pains and effort have brought this model of the "space-ship" of the future into being. The rocket is seven feet long, and calculated not only to rise to a height of miles from the earth but to return without destruction on a parachute device. Naturally, the discharge of such a missile from the front lawn of the American Museum of Natural History would scarcely be safe; and actual tests (in a less populous territory) will not take place until the spring. When they do, one wishes them every success.

"As a matter of fact, a good deal of serious theoretical work and a certain amount of practical experimentation have already been done upon the problems of rocket flight and interplanetary travel. The Germans, who so far have been the leading investigators of the "raumschiff", are credited with having driven one rocket to a height of more than a mile. Many other of the innumerable problems which the subject raises have been attacked, from the proper design of the combustion chamber or "reaction motor" to the question of fuel and fuel supply, or even to such remoter problems as that of whether the human frame could withstand the violent accelerations anticipated. A white mouse has given evidence upon the latter point; he was spun for a minute under a centrifugal pull more than eighty-two times that of gravity, and though he emerged staggering and dizzy he had "regained his balance" at the end of a minute, and no further deleterious effects could be detected.

"Despite these advances, there are probably many who will not clamor for a place in the first rocket expedition into the outer darkness. About a plunge into space there is something appalling as well as fascinating. Nevertheless, it is pleasant to think that there are people in the world who, for no material gain whatever, can give their interest and scientific enthusiasm to these bold possibilities of human invention."

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BOOTHROYD DENIES METEOR DANGER

In the February issue of the Bulletin, we reprinted an editorial from the New York Times, commenting on the meteor danger to interplanetary explorers. The thesis of the editorial was based upon the recent statements of Dr. S. L. Boothroyd of Cornell University, who has been studying extensively the activity of meteors from the Lowell Observatory. In order to obtain directly from Dr. Boothroyd his opinion on the meteor danger, David Lasser, president of the American Interplanetary Society wrote to Dr. Boothroyd for a statement. Mr. Lasser asked if it was not true, as Dr. Goddard had pointed out many years ago, that although meteors were numerous in space their density was so small that a space ship traveling to the moon would have only one chance in several million of being hit. Dr. Boothroyd's answer follows:

"Dear Mr. Lasser:

"In answer to your letter of January 16, I would say that I have not as yet issued any formal report of the work we have done since the Expedition (the Arizona Meteor Expedition) was organized and began work on October 1, 1931. My own telescopic observations of meteors, using the conical motion mirror to determine their angular velocities, reveal many meteors which reach the upper atmosphere with velocities of the order of hundreds of miles per second. However, they are of such small mass that they would not endanger astronauts traveling in a rocket in interplanetary space.

"Even most of the meteors observed with the naked eye would not endanger such travelers. The conclusions reached by Dr. Goddard are not affected by any discoveries we have so far made.

S. L. Boothroyd."

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TILING PLANS ROCKET TEST

The first rocket plane model carrying mail will start this Spring, according to Herr Tiling, who several months ago startled experts with his successful demonstrations of powder rockets.

Herr Tiling, who, unlike most other rocket engineers, avoided publicity before his rockets had emerged from the stage of laboratory tests, has already constructed the small mail rocketplane. It has a wing spread of little more than ten feet and is about nine feet long. About fifteen pounds of explosive material will propel it. The wings of the diminutive plane are folded against the body when the rocket starts and will spread only when automotically released as soon as the plane has reached its maximum velocity. When the fuel is exhausted the plane will glide down.

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STUDY FALLS OF COSMIC DUST

Fragments of exploded meteors reach the Earth's surface comparatively slowly, is the conclusion come to by Dr. Maud W. Makemson, of Rollins College, Florida. Large pans placed in high, isolated locations, collect the particles, which are usually round or regular in shape. They resemble volcanic glass or obsidian and range in color from transparent glass to amber, amethyst and smoky gray. The tiny globules are formed as a result of rapid cooling in the upper air. As might be expected, they are highly electrified. The question as to whether the particles were of true meteoric origin has been practically settled by the work of Dr. W. J. Fisher of Harvard, who has been collecting them for thirty years. In Dublin, Ireland, Hartley and Ramage collected dust from the Leonids of November 1897. In France Lucien Rudaux is at present investigating along this line.

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Meetings of the New York members of the American Interplanetary Society are held twice each month at the American Museum of Natural History, 77th Street and Central Park West. Associate membership in the Society at $3.00 per year may be obtained by sending the first year's dues to the Secretary, Nathan Schachner, 274 Madison Avenue, New York. Information on the other classes of membership, active and special may be obtained by writing the Secretary.